19
Agros 51.
2
799
A8M

U. S. DEPARTMENT OF AGRICULTURE.

F-12
J

FARMERS' BULLETIN No. 101.

LIBRARY
OFFICE OF
EXPERIMENT STATIONS
U. S. Department of Agriculture.

MILLETS.

BY

THOMAS A. WILLIAMS,
ASSISTANT AGROSTOLOGIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1899.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C. June 13, 1899.

SIR: I have the honor to transmit herewith, and to recommend for publication as a farmers' bulletin, a paper on millets, prepared under my direction by Mr. Thomas A. Williams, Assistant Agrostologist. The article is substantially the same as it appeared in the Yearbook for 1898, and its publication in separate form will permit of a more extended distribution of the important information it contains. The addition of the portion relating to the composition and digestibility of millets constitutes the most important feature of the revision.

In many sections of the United States the farmers are largely dependent upon annual grasses and forage plants for winter as well as summer feed for their stock. Millet is perhaps already more generally grown for this purpose than any other annual grass crop, but there are still many localities in which a judicious use of this plant would materially increase the possibilities for stock production. The many ways in which millet can be used in the rotation of crops on the average farm, and the variety of soil and climatic conditions under which the various sorts will thrive, make it an important element in American agriculture. Frequently a good crop of millet can be raised in no way interfering with the succession of primary crops, and increasing the income from the land by from $8 to $20 per acre.

The recent introduction, through the Department of Agriculture, of new and valuable varieties of millet has created a new interest in this crop among the farmers, and will undoubtedly result in its wider cultivation and more systematic efforts in the development, by selection and other means, of varieties better adapted to the varying conditions which prevail in the United States.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

FARMERS' BULLETIN NO. 101.—MILLETS. Page.

Introduction 5
Place of millets on the farm 5
Groups of the cultivated varieties 5
Culture of millets 20
Uses and feeding value 24
Fertilizing value of millets 27
Reputed injuriousness of foxtail millet forage 27

FARMERS' BULLETIN NO. 102.—SOUTHERN FORAGE PLANTS.

Introduction 5
Formation and care of pastures 6
Soiling and fodder crops 8
The more important hay and pasture plants 8
Adaptation of forage plants to soils 47

FARMERS' BULLETIN NO. 103.—EXPERIMENT STATION WORK.—XI.

A danger from excessive irrigation, and the remedy 5
Cross-pollination of plums 6
The close root pruning of fruit trees 13
The oxeye daisy 15
Poisoning by wild cherry leaves 16
Preserving eggs in water glass 17
The period of gestation in cows 18
The long clam 19
Silage for horses and hogs 20
Commercial butter cultures in connection with pasteurized cream 21
The stave silo 23
Explanation of terms 29

FARMERS' BULLETIN NO. 104.—NOTES ON FROST.

How frost is formed 5
Seasons of frosts 6
When to expect frost 7
Protection from frost 10
General observations and practical results 17
Conclusions 22

FARMERS' BULLETIN NO. 105.—EXPERIMENT STATION WORK.—XII.

Seaweed 5
Summary 9
The tillering of grains 10
Fertilizers for garden crops 12
Sweet corn and pole beans under glass 13
Girdling or ringing grapevines 17
Cereal breakfast foods 19
Food value of apricots, cherries, peaches, plums, and prunes 22
When to cut alfalfa 24
Spontaneous combustion of hay 26
Preservation of milk by pressure 27
Cream raising by dilution 28
Explanation of terms 30

FARMERS' BULLETIN NO. 106.—BREEDS OF DAIRY CATTLE.

Introduction 5
Ayrshires 6
Brown Swiss 11
Devons 15
Dutch Belted 18
Guernseys 20
Holstein-Friesians 24
Jerseys 29
Polled Durhams 35
Red Polls 38
Shorthorns 41
Appendix 46

FARMERS' BULLETIN NO. 107.—EXPERIMENT STATION WORK.—XIII. Page.
Fertilizer requirements of crops 5
Persimmons 9
Forcing rhubarb 13
Ear corn versus corn-and-cob meal for cows 16
Waste in feeding cornstalks 16
Molasses as a food for farm animals 17
Recent experiments in feeding ducks 20
The cost of raising calves 21
Feeding calves with milk of tuberculous cows 23
Killing the germ of tuberculosis in milk 24
Ropy milk and cream 26
Dairy salt 28
Explanation of terms 31

FARMERS' BULLETIN NO. 108.—SALTBUSHES.
General characteristics 5
Distribution of seed 5
How to sow the seed 6
Introduced saltbushes 7
American saltbushes 12
Composition of the saltbushes 14
Food value of the saltbushes 15
Miscellaneous alkali plants 16
Alkali and alkali soils 17
Conclusions 19

FARMERS' BULLETIN NO. 109.—FARMERS' READING COURSES.
Origin and purpose 5
Development in the several States 7
Reflections upon the reading courses 14
Publications on agriculture used or recommended in farmers' reading courses 16

FARMERS' BULLETIN NO. 110.—RICE CULTURE IN THE UNITED STATES.
Introduction 5
Varieties of rice 5
Production and importation of rice 6
Rice-growing sections 7
Soils adapted to rice 8
Rice lands 9
Irrigation 9
Preparing the ground 10
Drainage 11
Sowing 12
Flooding 13
Uniform ripening 14
Fertilizing 14
Weedy grasses 15
Red rice 16
Harvesting 17
Thrashing 18
The question of labor 18
Yield of rice 19
Rice milling 19
Effects of fashion in rice 21
Rice as a food 23
By-products of rice culture 23
Rice cultivation in southwestern Louisiana and southeastern Texas 25
Prospects for extension of rice industry 27

FARMERS' BULLETIN NO. 111.—THE FARMER'S INTEREST IN GOOD SEED.
Introduction 7
Relation between quality of seed and amount to sow per acre 8
Weed seeds sown on the farm 8
Low-priced seed may be expensive 9
Results of some tests 10
Remissness of dealers in seeds 18
How to secure good seed 18
Summary 23

FARMERS' BULLETIN NO. 112.—BREAD AND THE PRINCIPLES OF BREAD MAKING. Page.
Introduction ... 7
Grains and flours ... 8
Yeast and other leavening agencies ... 15
Raised bread ... 19
Special breads ... 24
Household methods of bread making ... 25
Baking and cooling ... 26
Chemical composition ... 28
Stale bread ... 29
Imperfections and impurities in bread ... 30
Nutritive value and cost of bread ... 32
Summary ... 37

FARMERS' BULLETIN NO. 113.—THE APPLE AND HOW TO GROW IT.
Introduction ... 5
Historical notes ... 5
Uses of the apple ... 9
Propagation ... 7
Locating an orchard ... 13
Drainage ... 15
Use of fertilizers and of clover ... 15
Preparing the land for planting ... 16
Distances for planting ... 17
Season for planting ... 17
Selection of trees ... 17
Lists of varieties suited to large areas ... 19
Planting ... 24
Losses by lack of care ... 25
Culture ... 25
Pruning and training ... 26
Protection from mice and rabbits ... 29
Gathering the crop ... 29
Disposition of the crop ... 31
Summary ... 31

FARMERS' BULLETIN NO. 114.—EXPERIMENT STATION WORK.—XIV.
Influence of salt and similar substances on soil moisture ... 5
Methods of securing extra early potatoes ... 6
The rotting of cranberries, and a proposed remedy ... 9
Chestnuts ... 9
Low-grade Paris green ... 14
Crude petroleum as an insecticide ... 15
Skim milk in bread making ... 16
The number of laying hens that may be profitably kept in one pen ... 18
A nest box for keeping individual egg records ... 19
Profitable and unprofitable cows ... 21
Explanation of terms ... 27

FARMERS' BULLETIN NO. 115.—HOP CULTURE IN CALIFORNIA.
Introduction ... 5
Botanical features of the hop plant ... 5
Varieties of hops ... 6
Where grown and yield per acre ... 7
Climatic conditions ... 8
Beginning of the industry in California ... 8
Methods of culture ... 9
Systems of training ... 11
Tying up the vines ... 12
Harvesting ... 13
Curing hops ... 14
Baling ... 20
Marketing ... 22
Prices, wages, and expenses ... 22
Conclusion ... 23
Some hop statistics ... 24

FARMERS' BULLETIN NO. 116.—IRRIGATION IN FRUIT GROWING.
Introduction ... 3
Irrigation and cultivation, and their mutual relations ... 5

FARMERS' BULLETIN NO. 116.—IRRIGATION, ETC.—*Continued.* Page.
Effects of insufficient moisture ... 10
When shall water be applied? ... 11
Flowing water versus falling water ... 14
Development and utilization of irrigation water ... 15
Preparing land for irrigation ... 26
Methods of applying irrigation water ... 27
How much water is used ... 44
After treatment of irrigated land ... 45
Cover crops in the irrigated orchard ... 46
Minor results of irrigation ... 47

FARMERS' BULLETIN NO. 117.—SHEEP, HOGS, AND HORSES IN THE PACIFIC NORTHWEST.
Sheep husbandry in the Pacific Northwest ... 5
Hog raising in the Northwest ... 16
The horse industry of the Northwest ... 23

FARMERS' BULLETIN NO. 118.—GRAPE GROWING IN THE SOUTH.
Introduction ... 5
Location and soil ... 6
Propagation ... 7
Selection of varieties ... 11
Planting, cultivating, and fertilizing ... 15
Pruning ... 17
Trellises and systems of training ... 20
The fruit ... 25
Insects and remedies ... 27
Fungous diseases and remedies ... 31

FARMERS' BULLETIN NO. 119.—EXPERIMENT STATION WORK.—XV.
Storing apples without ice ... 5
Cold storage on the farm ... 9
Mechanical cold storage for fruit ... 12
Keeping qualities of varieties of apples ... 16
Improvement of blueberries ... 18
Transplanting muskmelons ... 20
Banana flour ... 20
Fresh and canned tomatoes ... 21
Purslane ... 22
Establishing a flock of mutton sheep ... 23
Effect of cotton-seed meal on the quality of butter ... 24
Light versus heavy grain feeding for milch cows ... 25
Protecting Northern cattle against Texas fever ... 27
Explanation of terms ... 29

FARMERS' BULLETIN NO. 120.—THE PRINCIPAL INSECTS AFFECTING THE TOBACCO PLANT.
Introduction ... 5
The tobacco flea-beetle ... 5
The tobacco horn worms, or hornblowers ... 10
The bud worms ... 14
The new tobacco bug, or "suck fly" ... 16
Other sucking bugs ... 18
The tobacco leaf-miner, or "split worm" ... 19
Cutworms ... 22
Other tobacco leaf-feeders ... 24
The cigarette beetle ... 26
Other insects injuring dried tobacco ... 30
Foreign tobacco insects which have not yet reached the United States ... 31
Conclusions ... 31

FARMERS' BULLETIN NO. 121.—BEANS, PEAS, AND OTHER LEGUMES AS FOOD.
Introduction ... 5
Geographical distribution ... 5
The bean ... 6
The pea ... 12
The lentil (*Lens esculenta*) ... 14
The peanut (*Arachis hypogœa*) ... 15
Nutritive value of the legumes ... 16
Digestibility of the bean, pea, and lentil ... 18
Vegetable protein compared with animal protein ... 21

FARMERS' BULLETIN NO. 121.—BEANS, PEAS, ETC.—*Continued.* Page.
Extent to which legumes are used in dietaries 22
Preparation of legumes for food 23
Comparative value of legumes in relation to their cost 30
Summary 32
FARMERS' BULLETIN NO. 122.—EXPERIMENT STATION WORK.—XVI.
Liming grass lands 5
Early plowing for wheat 7
Grafting grape cuttings 9
Culture and uses of olives 11
Nuts as food 18
Coffee substitutes 22
The working of a pure food law 23
Selling eggs by weight 24
Relation of feed to the flavor of eggs 25
Feeding moldy corn 26
Preparation of unfermented grape juice 27
Explanation of terms 31
FARMERS' BULLETIN NO. 123.—RED CLOVER SEED: INFORMATION FOR PURCHASERS.
Points in selection of clover seed 3
Field tests of American and European clovers 8
FARMERS' BULLETIN NO. 124.—EXPERIMENT STATION WORK.—XVII.
Distilled water for drinking purposes 5
Soil inoculation for leguminous plants 7
Treatment of sandy soils 10
Fertilizing value of different forms of lime 12
Nitrogenous fertilizers for market-garden crops 12
Pecan culture 16
Weed destruction by means of chemicals 19
Maple sirup and sugar 21
Value of cotton seed to the farmer 24
Alfalfa silage 25
Forage crops for pigs 25
Grazing steers on corn and cowpeas 27
The type of the dairy cow in relation to milk and butter production 28
FARMERS' BULLETIN NO. 125.—PROTECTION OF FOOD PRODUCTS FROM INJURIOUS TEMPERATURES.
Introduction 7
Shipment of perishable products 7
Storage of perishable products 15
Temperatures favorable for slaughtering animals, and preservation of the meat 22
Use of weather reports in connection with safe storage and shipment of food products 23
Temperature scale 25

348250

CONTENTS.

	Page.
Introduction	5
Place of millets on the farm	5
Groups of the cultivated varieties	5
Foxtail millets	6
Origin and extent of cultivation	6
Habit and conditions of growth	8
Varieties	8
Barnyard millets	13
Origin and extent of cultivation	13
Varieties	14
Broom-corn millets	18
Origin and extent of cultivation	18
Varieties	19
Culture of millets	20
Preparation of the soil	20
Seeding	21
Harvesting	22
Uses and feeding value	24
Composition and digestibility	25
Fertilizing value of millets	27
Reputed injuriousness of foxtail millet forage	27

ILLUSTRATIONS.

		Page.
FIG.	1. German millet	10
	2. Korean Foxtail millet	13
	3. "Ankee" millet	15
	4. Shama millet	17
	5. Broom-corn millet	18
	6. Japanese broom-corn millet	19

MILLETS.

INTRODUCTION.

The term "millet" is used in a general way to designate certain cereal and forage grasses, the seeds of which are usually small as compared with other cereals, such as oats, wheat, and barley. In some parts of the world certain of the sorghums are included under this name, while in this country several grasses of quite different character are locally called millets.

Millets are important both as forage plants and as a source of food for man. In nearly all parts of the world they take a prominent place among forage crops, and it is estimated that they feed about one-third of the inhabitants of the globe. Between 35,000,000 to 40,000,000 acres of millets are grown annually in India, and Japan alone uses about 35,000,000 bushels of seed each year for human food. Korea, China, and other Asiatic countries also use enormous quantities for this purpose.

PLACE OF MILLETS ON THE FARM.

On the whole, it is doubtful if there are many sections in this country where millets should be made a primary crop. Their place is rather that of a supplementary one—a "catch crop," when the corn has been destroyed by hail or otherwise; a substitute for corn where that crop is not easily grown; a crop to be grown on a piece of land that might otherwise lie idle; a readily available crop for use in short rotations; an excellent thing to grow on foul land to get rid of weeds, giving practically the same results as fallowing, or summer cultivation, and in addition a crop of forage; a supplement to the regular and permanent pastures and meadows. It is in such ways that the millets are most valuable on the average farm, and such is the place they should be given in American agriculture.

GROUPS OF THE CULTIVATED VARIETIES.

In this paper the discussion is limited principally to varieties of recognized merit already on the market, leaving new and untried sorts until such a time as experimentation will have demonstrated their value

for general cultivation. It is not desirable to consider at length the relative merits of the various trade names used by seedsmen in placing their millets on the market. As far as possible, these names have been grouped as synonyms under the most generally accepted titles of the various standard varieties.

But little has been done in the really scientific development of varieties. In a few instances careful selection has been practiced, but as a rule the so-called new varieties on the market are only local variations of well-known sorts. During recent years a number of the experiment stations have been paying special attention to the introduction and testing of foreign millets, and the Department of Agriculture has distributed seed of a number of foreign sorts to the various State experiment stations and to private individuals in different parts of the country. Out of the many kinds thus introduced and tested some are giving promise of value for cultivation, and there is no doubt that others could be crossed with some of the standard varieties in such a manner as to materially increase their value.

With one or two exceptions, the millets grown in the United States belong to the genera Chætochloa and Panicum, and may be arranged into three groups. In the first group are those belonging to the genus Chætochloa (formerly Setaria), with a compact, bristly, foxtail-like head, closely related botanically to the common foxtail grasses of the fields and waste places; this group, which may be termed the foxtail millets, includes such varieties as Common Millet, Hungarian, and others originating from the various species of Chætochloa, chiefly *C. italica* and its var. *germanica*. A second group is composed of varieties derived from the common barnyard grass (*Panicum crusgalli*) and its allies (*P. colonum*, *P. frumentaceum*, etc.), distinguished by the dense paniculate heads so characteristic of barnyard grass; although extensively cultivated in parts of the Old World, the millets of this group, which may be designated the barnyard millets, have only recently come into prominence in American agriculture. The third group comprises millets with bushy heads, the seeds being produced at the ends of the comparatively long branches; this group includes the "common" millet of the Old World and the varieties derived from the same species (*Panicum miliaceum*), regarded by many as the true millets, as they undoubtedly are in fact; in the United States they are most generally known as the broom-corn millets, which title has been adopted in this paper.

FOXTAIL MILLETS.

Origin and extent of cultivation.—The foxtail millets (*Chætochloa italica* and var. *germanica*) are by far the most important group of millets grown in this country—probably in the whole world. There is a difference of opinion as to the nativity of this species. Some writers regard it as a native of southern Europe; but although it has been cultivated

there from the remotest period, there seems to be no good evidence of its being a native. Writers on Chinese economic plants give this as one of the five plants sown each year by the Emperor in a public ceremony, in accordance with the command given by Chin-nong, 2700 B. C. These plants are all regarded by the Chinese as natives of that country. The species seems to occur in the wild state in Japan. De Candolle, the leading authority on the "Origin of cultivated plants," after an extended discussion of all the evidence obtainable, concludes as follows:

> The sum of historic, philological, and botanical data makes me think that the species existed before all cultivation, thousands of years ago, in China, Japan, and the Indian archipelago. Its cultivation must have early spread toward the West, since we know Sanskrit names, but it does not seem to have been known in Syria, Arabia, and Greece, and it is probably through Russia and Austria that it early arrived among the lake dwellers of the stone age in Switzerland.

According to Hackel, the common weedy grass known as Green Foxtail (*Chætochloa viridis*) is to be regarded as the probable original form of the cultivated foxtail millets.

In some of the many varieties foxtail millets have long held an important place among the plants cultivated over large portions of Europe, Asia, Africa, and America. There is much doubt as to the exact time and manner of the introduction of these millets into this country. The opinion prevails that the variety known as Common Millet was the first to be introduced, probably near the close of the last century. Hungarian grass was certainly grown in this country as early as 1830, and was probably introduced[1] some time before that date. Both the German and Japanese millets are of later introduction.

At the present time these millets are more or less extensively grown throughout temperate Europe, a large part of India, China, Japan, northern Africa, the United States, and Canada. In the United States their cultivation is most general in the middle West, although they are grown more or less throughout the country. In parts of the South they are replaced to some extent by sorghum, while in the North the broom-corn millets are sometimes grown in their stead, and of recent years the barnyard millets are gaining favor in some sections. Among the leading millet-growing States are Iowa, Missouri, Kansas, Texas, Nebraska, the Dakotas, Minnesota, Illinois, and Tennessee.

In this country the foxtail millets are grown almost exclusively for forage, but in other parts of the world they are used for human food; in early times they were probably much more extensively used for this purpose than at present. Seed of this species has been found in such abundance in the remains of the lake dwellings of Switzerland as to indicate that it was in common use during the stone age in central and southern Europe. Long before the Christian era, at least as early as 2700 B. C., it formed one of the chief sources of food in China, and is

[1] Mich. Agr. Exp. Sta., Bul. No. 117, pp. 23, 24. 1894.

still extensively used for this purpose, not only in China, but also in Korea, Japan, the East Indies, and Trans-Caucasia. Church[1] says it is grown in India chiefly as an "intermediate or subordinate" crop, and is largely used as human food in certain parts of the country. He further says: "It is generally regarded as nutritious and digestible, but in some places it is considered to be rather heating." It is usually prepared by parching or boiling, and is eaten alone, or may be mixed with milk and sugar, forming a mixture known among the natives as "sir." At the present time it is widely grown for forage in foreign countries, particularly in central Europe and in parts of India.

Habit and conditions of growth.—The foxtail millets delight in rich, warm, loamy soils, and will not thrive in soils that are poor and thin. This is particularly the case with the coarser varieties like German Millet. Common Millet and Hungarian usually give better results under adverse conditions of soil and climate than the other varieties commonly grown in this country. The foxtail millets are strong, rapid growers, and draw nourishment largely from the surface soil. The great mass of strong, fibrous roots have a beneficial effect on the physical condition of the soil, particularly in the case of lands recently brought under the plow. A crop of millet on new "breaking" aids materially in subduing the land and in preparing it for the succeeding crop. In many localities, notably in the West, millet is an excellent crop to precede corn. In the South the foxtail millets are regarded as well adapted to the upland soils of the cotton regions, Common Millet being best for the light soils and German Millet for low, heavy soils.

The foxtail millets not only endure excessive heat and sunlight well, but make very rapid growth if the supply of moisture is not too limited. They are, however, very susceptible to cold, particularly when the plants are young. The length of time required to reach maturity varies a great deal, according to the variety and the soil and climatic conditions, the commonly grown varieties ordinarily being ready to cut for hay in from fifty to eighty days from date of sowing, and maturing seed in from ten to fifteen or twenty days later. Under very favorable circumstances some of the varieties may be in condition to cut for forage within a month or six weeks from time of seeding.

Varieties.—The various foxtail millets commonly found on the market in the United States may be grouped under the following standard varieties: (1) Common Millet (*Chætochloa italica*); (2) German Millet (*Chætochloa italica*); (3) Golden Wonder Millet (*Chætochloa italica*); (4) Hungarian Millet (*Chætochloa italica* var. *germanica*).

Several seed firms are also offering "Japanese millets;" but different sorts are offered under practically the same name, and sometimes the seed sent out is apparently only that of one of the common varieties, so that it is scarcely possible to make a suitable classification at the present time. The two Japanese sorts which have received widest dis-

[1] Food Grains of India, p. 55.

tribution are mentioned in the pages following in connection with certain standard sorts with which they seem most closely associated.

Seed of the Korean millets has not yet been placed on the general market, but as some of the forms give promise of much value for cultivation in this country they are given a place in this discussion.

Common Millet.—Synonyms: Small Millet (Texas), Californian Millet (Salzer, Vilmorin), Dakota Millet (in part, of some seedsmen), Early Harvest Millet or Missouri Millet (at least in part), American Millet (in part).

Common Millet was one of the first varieties to be introduced and to come into general cultivation in the United States, but there seems to be no record of the exact date of its introduction. At the present time it is the most widely cultivated of the foxtail millets in this country. It is the hardiest of the commonly grown varieties, enduring drought the best and giving better returns on poor soils. By most feeders the hay from this variety is preferred to that from others on account of its finer quality, there being less loss in feeding it. Although German Millet will usually outyield Common Millet under favorable conditions of soil and moisture, the latter will, one year with another, afford more forage of a finer quality in most localities in the Northern States.

Common Millet is one of the earliest of the foxtail millets, and is the most constant in its characters. Although this variety seems to have been long known in Europe, its cultivation is by no means so general there as in the United States; indeed, the variety seems to have reached its perfection in this country, and is being taken back to the old country under such names as "American Millet," "Californian Millet" (Moha Vert de Californie, Vilmorin), etc.

As a rule, seed sold in our markets under the name of Common Millet is true to name. Occasionally seed of this variety is sold as German Millet, and much of the "Dakota Millet" is nothing but Common Millet, although most of it is probably an early strain of German Millet, as stated elsewhere.

By some Early Harvest or Missouri Millet is regarded as a distinct variety, mainly because of its earliness and short, compact heads. Professor Crozier inclines to this opinion and regards Hungarian as the probable ancestor, although the introducers claim the variety to be a cross between Golden Wonder and Broom-corn millets, which can scarcely be the case. Professor Chilcott regards it as only a variation of Common Millet. Plants from seed obtained under this name from the introducers in 1897 are almost exactly like Common Millet from the same source, and plainly belong to that variety.

German Millet (*fig. 1*).—Synonyms: Southern Millet, American Millet (in part), Golden Millet, Mammoth Millet, Bengal Grass, Dakota Millet (for the most part).

This variety has been in general cultivation in the South since the early seventies, but was introduced into the United States many years earlier. Professor Crozier regards the East Indies as the most probable source of its introduction into the United States, and remarks that "the name Bengal Grass, by which it was first known in this country, suggests such an origin." Flint, on the contrary, makes the statement that it was first brought to the United States from Europe. However this may be, it seems that the seed used in Tennessee, where this variety first came into real prominence, was brought from France in the early sixties, and since that time this has been the leading millet sown in the South.

FIG. 1.—German Millet: *a* and *b*, two views of the spikelet with its cluster of three "beards;" *c*, "seed."

German Millet makes a heavy yield of forage under favorable conditions, but does not stand drought as well as the smaller varieties, such as Common Millet and Hungarian. The hay is coarser and less highly valued than that from the smaller millets, but when the forage can be fed in the green state this will be found to be an excellent variety to grow, on account of the heavy yield.

German Millet is the latest of the varieties commonly grown here, and is exceedingly variable in its appearance and habit of growth. It is very seldom that one sees a field that is uniform in character. Many, perhaps most, of the heads may be typical of the variety, but usually there will be many others scarcely to be distinguished from Common Millet or other standard varieties. Typical German Millet brought from the South soon becomes very much modified when grown in the North. Thus, in a northern strain of German Millet sold as "Dakota Millet" or "Dakota-grown German Millet" the "seed" is larger and more oval in shape than in the typical southern form; the plants are earlier and hardier, and the yield of forage is usually better, at least in northern localities.

Some of the so-called Japanese millets now on the market belong to the German Millet type; as, for example, "Breck's Japanese Millet,"

which is scarcely distinguishable from the common southern German Millet.

Golden Wonder Millet.—Synonyms: Sometimes confused with the so-called Golden (German) Millet.

According to Professor Crozier,[1] "this variety originated in Minnesota in 1884 and was first offered to the public four years later." Its introducers claimed it to be "an artificial cross produced by one of their growers between Hungarian Grass and German Millet." It shows undoubted relationship to German Millet in its large head, coarse leaves, and robust, simple stems, but there is no evidence of Hungarian parentage in any of its prominent characters. While such a cross is no doubt possible, it would seem that Hungarian characters would enter more strongly into those of the offspring.

In yield of seed Golden Wonder leads all the other varieties of foxtail millets. The forage is coarse, like that from German Millet, and the yield heavy under favorable conditions, but Golden Wonder is even more susceptible to drought than German Millet, and is therefore less generally grown than any other of the well-established varieties. At the present time it is most extensively cultivated in the States along the Upper Mississippi and Lower Missouri valleys. Much of the seed sold under this title is untrue to name. German Millet is perhaps oftener sold as Golden Wonder than any other variety.

There is an Italian variety of millet sold by Vilmorin, of Paris, which is very much like Golden Wonder in size, appearance, and time of ripening, and also a Japanese variety sold by Gregory & Son which is perhaps scarcely to be distinguished from it, although when grown under similar conditions the heads of the Japanese form are usually rather smaller and more symmetrical, more closely flowered, and the "seeds" are rounder and of a deeper yellow.

Hungarian Millet.—Synonyms: Hungarian Honey, Hungarian Grass, German Millet (in the Old World and in small part in this country).

Hungarian Millet seems to have been first brought into the United States soon after the introduction of Common Millet. According to Professor Crozier,[2] the time of its (Hungarian) first introduction into the United States is unknown, but as early as 1830, and probably much earlier, it was in cultivation here. It did not gain much prominence as a forage crop, however, until about 1855–56, or a couple of years after the seed was introduced from France and distributed by the Patent Office. It was sent out under the name of "Moha de Hongrie," which had been given to it by the French, and our own common names of Hungarian Grass and Hungarian Millet probably came from that.

This millet first came into general cultivation in the Middle West. In Iowa it won favor at once, and as early as 1856 was a most valuable

[1] Mich. Agr. Exp. Sta. Bul. No. 117, p. 41. 1894.
[2] Mich. Agr. Exp. Sta. Bul. No. 117, p. 26. 1894.

forage crop, particularly on recently broken land. At the present time it is more widely grown in the North than in the South. By most farmers it is placed next to Common Millet as a hay crop, the quality being regarded as better than German Millet.

Hungarian Millet does not resist drought as well as Common Millet, but with favorable conditions of soil and moisture it will usually give a somewhat heavier yield. One reason why Hungarian has not found more favor with farmers generally is that it shows a greater tendency than other common varieties to persist in the soil when allowed to mature seed before harvesting. In portions of the Missouri Valley region, as in eastern Nebraska and Iowa, this millet received a great deal of attention from farmers during the seventies, and fine crops of hay and seed were obtained, but its tendency to "volunteer" brought it into more or less disfavor, and it is now less commonly grown than either Common Millet or German Millet. It seldom becomes troublesome, however, except on light, sandy soils or land recently brought into cultivation. On moist, heavy soils or in regions where there is a great deal of wet weather during the fall and winter months it is not likely to make much volunteer growth.

A millet has been recently placed on the market by a Northwestern seed firm under the name of "New Siberian Millet," which, although regarded by some as but a form of Hungarian, seems to possess characters which, if constant, will entitle it to rank as a distinct cultivated variety. At the South Dakota experiment station it was regarded as the best millet grown during the season of 1897. The plants are larger than Common Millet, with a habit of growth, beard, and chaff much like Hungarian; heads drooping, larger than in either Common Millet or Hungarian, tapering at both ends, with rather conspicuous, closely flowered subdivisions; "seed" of about the same size and shape as Common Millet and Hungarian, orange colored.

Japanese Foxtail Millets.—Under the name of "Japanese Millet" several different kinds of Foxtail millets are being grown in various parts of the country. Some of these are apparently identical with varieties already grown in this country, and others are so closely allied that further study is necessary before they can be given a place either as distinct varieties or as forms of better known sorts. As illustrating this point, such cases may be cited as "Breck's Japanese Millet," mentioned under the discussion of German Millet, and Gregory's "Japanese Millet," noted under the head of Golden Wonder Millet. Several sorts imported from Japan by Professor Brooks seem more distinct as cultivated varieties, and will no doubt soon be given appropriate trade names.

As a rule these Japanese millets are comparatively large forms, giving heavy yields of seed or forage under favorable conditions, but with little ability to withstand drought, succumbing quicker than any of the commonly grown sorts. Some of them, however, have given good results in certain localities, and it is not unlikely that they may

ultimately prove to be desirable for general cultivation, or valuable sorts may be developed from them by selection and crossing.

Korean Foxtail Millets.—Several millets recently introduced from Korea have been grown at some of the State experiment stations and on the experimental grounds of the Department of Agriculture at Washington, D. C. These varieties are seemingly quite different from those already grown in this country, and deserve further experimentation. Two of the varieties seem particularly hardy in the District of Columbia. Both have clustered, branching stems. In one (fig. 2) the head is slender, nearly cylindrical, erect or somewhat nodding; beards very long and conspicuous; chaff green or purplish; "seed" green or purplish, with quite conspicuous transverse wrinkles, rather pointed at the ends, medium sized. In the other the head is larger, quite erect at first, but nodding slightly after a time, conspicuously bearded, tapering at each end, composed of narrow, rather conspicuous subdivisions; chaff green or purple; "seed" much as in the preceding, but less often dark colored, and possibly averaging narrower and slightly smaller.

Both these varieties "volunteer" quite readily, the larger perhaps showing the greater tendency to do so.

FIG. 2.—Korean Foxtail Millet.

BARNYARD MILLETS.

Origin and extent of cultivation.—The term "Barnyard Millet" was first applied to the cultivated varieties of the cosmopolitan barnyard grass (*Panicum crus-galli*) by Prof. W. P. Brooks in 1896.[1] In the present paper the application has been extended so as to include not only all the varieties derived from *Panicum crus-galli*, but also those

[1] Eighth Ann. Rep. Mass. (Hatch) Agr. Exp. Sta., p. 31.

belonging to *Panicum colonum*, *P. frumentaceum*, and other species of Panicum with the same type of inflorescence and habit of growth.

The true barnyard grass is very widely distributed and varies exceedingly in its botanical characters. It occurs throughout the United States in fields and waste places, usually as a coarse-growing plant, with broad leaves and widely spreading stems, producing large irregular "heads" of flowers and seeds. There is much variation in the habit of growth, however, some of the forms having upright stems which branch but little. There is also much variation in the color of the "heads" and in the bearded character of the chaff (glumes), the color varying from green to purple-brown and the glumes strongly bearded or with the beards nearly or quite wanting (var. *muticum*).

In many parts of the Old World barnyard grass is not only grown for forage, but also as food for man. Thus, in India, under the name of "bharti," it is grown as a forage crop and is also often harvested as a grain, the seed being used as food by the poorer classes in the same way as that of "Shama" Millet (*Panicum colonum*) and of "Sanwa" Millet (*P. frumentaceum*), both of which are extensively grown for this purpose in parts of Asia. Speaking of the cultivation of *Panicum frumentaceum* in Japan, where it is known as "hie," Professor Georgeson says "this is a very common crop in all parts of Japan, especially in the hilly districts, where there is no suitable rice land, or where water is not available for irrigation. It is grown entirely for its seed, which, when thrashed out and cleaned, is ground and used for food, being eaten mostly as a porridge."[1]

Varieties.—*True Barnyard Millets.*—These are undoubtedly the most valuable varieties of this group for cultivation in this country. The varieties that give best results under cultivation are those with upright habit of growth, a close "head," and a tendency to produce a large quantity of leaves. Of the varieties at present grown in the United States, one of the recently imported Japanese sorts is probably the most promising. It is a coarse-growing form with a heavy leafage and compact beardless heads. This variety has been thoroughly tested by Professor Brooks at the Massachusetts experiment station, and is highly recommended by him as a forage crop. It matures a crop of hay in about two and one-half months.

There are several valuable varieties in various parts of our own country, the most notable being those found in prairie regions of the West and Northwest and the "Ankee" grass (fig. 3) of the Southwest. In the artesian-well region of the Dakotas there are wild forms of barnyard grass that seem particularly well adapted to the conditions that prevail in the vicinity of the flowing wells, especially where the soil has been watered too freely. In many places considerable areas about the ponds and along the ditches are covered each season with a growth from 3 to 6 feet high. Similar areas may be seen elsewhere in

[1] Mich. Agr. Exp. Sta. Bul. No. 117, p. 47.

the West and Northwest in irrigated regions, and they are yearly becoming more common. In the southwestern part of the United States there is a large, thrifty form of this grass, which makes a very fine growth in lowlands and swampy places during the wet season. It is known to the Mohave Indians as "Ankee," and its seed is said to be extensively used by them as food.

On the experimental grounds of the Department of Agriculture at Washington, D. C., "Ankee" makes a magnificent growth, reaching a height of 7 feet or more and maintaining a very characteristic upright habit of growth. It has also made luxuriant growth on the grounds of the station at Knoxville, Tenn., and at the Cornell, New York, Massachusetts (Hatch), and Michigan stations. It is one of the most promising of the inland forms of the species, and should be given an extended trial, particularly in sections where high temperatures prevail.

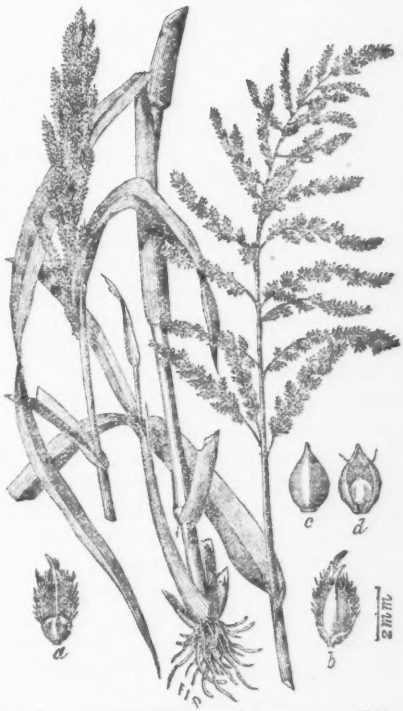

FIG. 3.—"Ankee" Millet: *a* and *b*, two views of the spikelet; *c* and *d*, two views of the "seed."

Professor Brooks, of the Massachusetts station, considers "Ankee" inferior to Japanese Barnyard Millet for a fodder crop for that locality on account of its lateness and the coarseness of the forage. "Ankee" grass is considerably later than the common forms of the species. Professor Brooks reported that plants from seed sown on May 4 failed to reach maturity, and at the Michigan station the same was found to be true of plants sown on May 20. This variety requires four months or more to mature seed.

In addition to the above-mentioned inland forms, there are coastal forms growing in brackish marshes and meadows along the seacoast, possessing much value for forage. One of these is quite different in appearance from all other forms of barnyard grass, and is probably specifically distinct. The lower leaf sheaths are very hairy and the "heads" are conspicuously bearded. The plants attain a height of from 3 to 6 feet. This grass may well be given a trial on saline soil in inland regions.

Barnyard Millet does not endure drought well, being more susceptible than the common sorts, and it can not be profitably grown on poor soils. On the rich prairies of the West and Northwest heavy yields may be obtained where the supply of moisture is sufficient, as when under irrigation. It seems to thrive better on the alkali soil so common in some parts of the West than either Common or German Millet. In some parts of the South, particularly in the lower Mississippi Valley, it makes a fine yield of hay, sometimes affording two cuttings a season, and although an annual, it continues to occupy the land year after year through the great readiness with which it reseeds itself. In these localities it furnishes a large proportion of the volunteer hay crop and is also used for soiling.

Under average conditions of moisture and fertility of the soil, Barnyard Millet is one of the most productive of the annual hay grasses. At the Massachusetts (Hatch) experiment station Professor Brooks has obtained a yield of 12 to 18 tons of fresh or 4 to 6 tons of cured forage per acre. He finds that under the conditions prevailing for the past few years this millet has outyielded all others grown on the station grounds. He suggests that by seeding early in May and cutting as soon as the plants come into bloom a second crop may be obtained and the yield of forage per acre be materially increased. The yield of seed from this millet compares favorably with that of other varieties, usually ranging from 40 to 60 bushels per acre. The seed is not as heavy as that of the broom-corn and foxtail millets, weighing but 35 pounds per bushel.

Shama Millet or Jungle Rice (*fig. 4*).—Shama Millet (*Panicum colonum*) is a grass with much the appearance of Barnyard Millet, but is smaller in every way, with a simpler inflorescence or "head." It is common in the tropical and subtropical regions of the Old World, where it is a native, and is widely introduced into the other warm regions of the globe. In the United States it occurs chiefly in waste places along roadsides and ditches, mostly in the South. It is quite abundant in parts of the Southwest and also in Mexico.

In India Shama Millet is one of the most valuable forage crops, and the seeds are used for human food. According to Church[1] "this millet is a poor food; it is used in some places by a considerable number of laborers as a usual article of diet." Duthie[2] says a food preparation called "khir" is made by boiling the grain in milk, and is eaten by the Hindoos on fast days. He also mentions another method of preparing the seed in which it is ground and made into a paste and eaten with milk. The seeds of this grass are also said to be used by the Indians in Mexico and the Southwestern United States. In many of the tropical regions it is regarded as a valuable forage plant, and is often extensively grown for this purpose. Both Duthie and Church gave it a prominent place among the fodder-producing plants of India, in the northern part of which it is in common use.

[1] Food Grains of India, p. 50. [2] Dict. Econ. Prod. Ind., No. 6, Part I, p. 7.

In the Southeastern United States this grass thrives on rich, moist soil and, in places, affords considerable forage of excellent quality; but little effort has been made to cultivate it. Several attempts to grow it in the North have met with poor success. At the Cornell experiment station it made a fair showing, "resembling poor specimens of Barnyard Millet, reaching about a foot in height."

Sanwa Millet.—Sanwa Millet (*Panicum frumentaceum*) is very closely allied to the true barnyard grass, and, like it, is a coarse growing plant, under favorable conditions yielding a large amount of herbage. Although extensively grown in other parts of the world, notably in southern and eastern Asia, but little attention has been given to it in the United States, and the few experiments made with it have not given encouraging results, except, perhaps, in the South. Professor Church,[1] in speaking of the cultivation and value of this grass in India, says "Sanwa is the quickest growing of all the millets; the harvest may take place within six weeks of the sowing. When it is sown in April or May it is cut in June and July; the June sowing is ready in August," and further, "Sanwa does not take a high place among the millets. It is either boiled as rice or boiled with milk and eaten with sugar, or it is parched." The stems and leaves are used for forage. In Japan the grass is said to make an excellent growth and afford large yields, though it is not grown for forage to any extent.

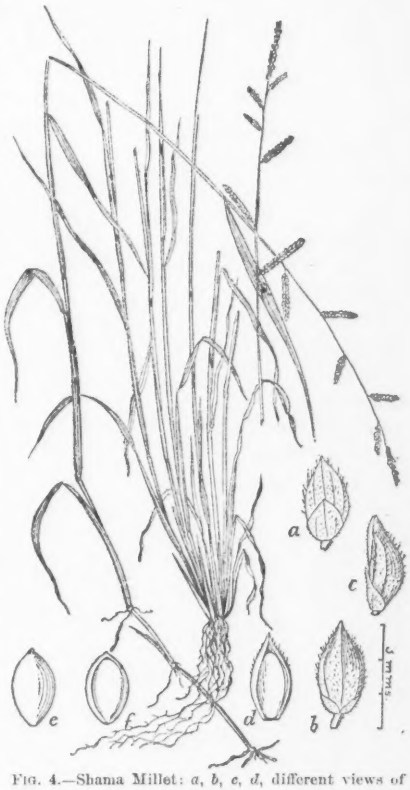

FIG. 4.—Shama Millet: *a*, *b*, *c*, *d*, different views of the spikelet and glumes, or chaff; *e*, *f*, two views of the "seed."

The various attempts to grow this millet in the United States have met with only limited success. At the Louisiana experiment station it is reported as doing "excellently," but its cultivation does not seem to have been undertaken to any great extent there. At the United States grass station, Knoxville, Tenn., the millet has made a fairly

[1] Food Grains of India, p. 49.

good showing. Plants from seed sown on May 7 reached a height of 3 feet by the middle of July and matured seed by August 23. The yield and quality of forage was good. It proved a failure at the Kansas experiment station, owing to the hot, dry summers. Further experimentation may prove it to be of some value for some sections of the South.

BROOM-CORN MILLETS.

Origin and extent of cultivation.—In the United States the term "Broom-corn Millet" is at the present time generally applied to this Old-World grass (*Panicum miliaceum*, fig. 5). It is the "common millet" of Europe, where it has been cultivated for centuries. A "millet," regarded by most authorities as this species, is mentioned by nearly all the early writers on cultivated plants, such, for example, as Theophrastus, Hippocrates, and others, and seems to have been extensively used as a grain in remote times. According to Heer it was much used by the Swiss lake dwellers of the stone age, and De Candolle, on the authority of Regazzoni, says it has been found in the remains of the lake dwellings of the Varese in Italy.

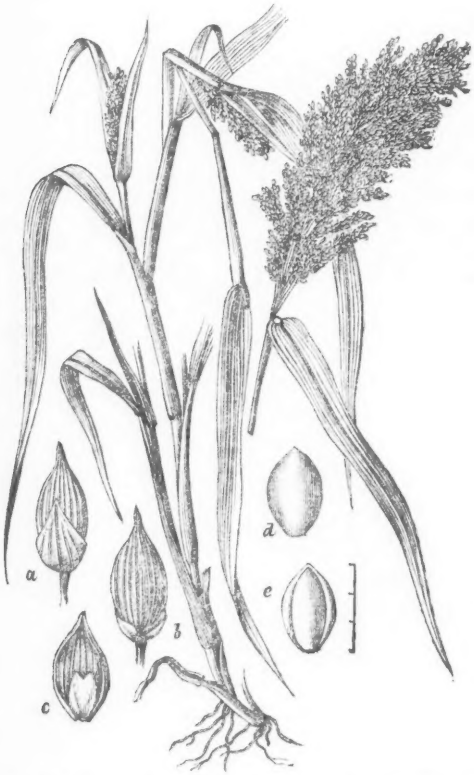

FIG. 5.—Broom-corn Millet: *a*, *b*, and *c*, views of the spikelet and glumes, or chaff; *d* and *e*, two views of the "seed."

The nativity of this millet is very uncertain. Although it grows spontaneously throughout southern Europe and many parts of Asia and Africa, there are apparently no really authentic cases of its having been found in a wild state. All the early records speak of it as being cultivated. Some writers, notably Linnæus, regard India as the original home of this millet; but De Candolle does not consider the records as at all conclusive, and thinks that "its Egypto-Arabian origin is very probable."

Church, in his "Food grains of India," says "it was early introduced and is largely cultivated in many parts of India."

It is also extensively grown in China and Japan as well as throughout southern Europe and elsewhere in the Mediterranean regions and north to central Europe. Although introduced into the United States many years ago, it has never been extensively grown over any large extent of territory, and at the present time is much less generally grown than the foxtail millets. It has not met with favor in the South, but in the Northwest is valued highly because of its ability to mature a crop of seed in the short, dry season so often prevailing in that region, thus serving to some extent as a substitute for corn.

Varieties.—The different cultivated varieties of Broom-corn Millet vary more or less in habit of growth and character of the panicle or "head," but the chief distinction lies in the color assumed by the mature seed. Three rather distinct types may be recognized, white, yellow, and red. These may intergrade more or less. The red sometimes becomes a very dark brown or almost black, and the "Millet noir ou gris" (black or gray millet) sold by Vilmorin, of Paris, France, gets its dark-gray appearance through the seed being marked with dark stripes on a lighter ground color.

FIG. 6.—Japanese Broom-corn Millet.

The general color of the growing plant varies considerably in the different varieties. Plants from the yellow-seeded varieties are usually light green in color, while those from the red-seeded sorts are more often tinged with red, usually in proportion as the seed is light or dark red. Thus, plants of a very dark-red-seeded Japanese variety grown the past season maintained a decided reddish-purple tinge throughout the entire period of growth, the color being most pronounced in the young plants, fading out as they became older, and deepening again in the panicle as the plants approached maturity. However, some of the white-seeded varieties may often become more or less tinged, as in the case of the variety sold as White French millet. By far the greater number of the varieties offered in the market by seedsmen in this country and the varieties most widely grown for forage belong to the group with yellowish seed. Such varieties are the Manitoba, Californian Beauty, French, Turkish, and Broom-corn, or Hog millets. There seems to be

little if any difference between these so-called varieties, either in appearance or value. Of the white-seeded sorts the most frequently grown are "White French," "Chinese" or "Chinese White," and "Japanese White." The white-seeded varieties seem to be more robust growers, as a usual thing, than either the yellow or the red seeded ones, the most productive being the Japanese White. There are but two of the darker or red-seeded varieties that have come into much prominence in this country. They are the "Red French" and "Japanese Red" (fig. 6).

The large coarse-growing varieties are valuable for soiling and may be used advantageously in the silo where corn and the heavier-yielding silage crops can not be successfully grown or when for any reason these crops are destroyed. The forage does not appear to have the laxative and diuretic action upon the animals eating it produced by the foxtail millets, and there are no harsh, irritating beards. However, objections have been made to it on account of the abundant growth of stiff hairs on the leaves and stems. The yield of forage is, on the average, less than may be obtained from the other millets, but on account of the relatively short season required for its development Broom-corn Millet may often produce a crop when the others would not. The yield of seed is large in proportion to the size of the plant, 50 to 60 bushels per acre being frequently reported from the Northwest.

CULTURE OF MILLETS.

PREPARATION OF THE SOIL.

For this crop a fertile, mellow soil is preferable. Loams with but little clay and not too much sand give the best results. Heavy clay soils require considerable working in order to get them into proper condition. For spring sowing the land may be plowed in the same manner and at about the same time, or perhaps a little later, as for a crop of corn.

Millets draw their nourishment largely from the surface soil; hence, the supply of plant food should be concentrated in the upper layers of the soil and should be in forms readily available to the plant. If the surface soil does not already contain sufficient available plant food, this should be supplied in the form of barnyard manure or commercial fertilizers; those containing large percentages of nitrogen, phosphoric acid, and potash in readily available forms are most valuable. Among such are muriate of potash, ground bone, cotton-seed meal, and tankage. The barnyard manure may be scattered on the land and plowed under, but the others had best be sown on the land after it has been plowed and worked into the soil with a harrow. The amount and the exact character of the fertilizer required will, of course, depend upon the kind and condition of the soil. In most instances a mixture of muriate of potash, nitrate of soda, and ground bone or superphosphate will be found beneficial, and on some soils

lime may be used to advantage. A light dressing of barnyard manure supplemented by a light application of some such mixture as the above will usually give good results in the East, while on the rich prairies of the West little, if any, fertilizing will be found necessary. In case the land is cloddy, as frequently happens when much clay is present, the harrow or roller should be used to reduce the surface to a smooth condition. This is necessary, because it is of prime importance that the seed bed should be in condition to insure prompt germination and an even development of the grass; it also facilitates the harvesting operations.

In the West it is the common practice to delay the preparation of the land for millet until near the close of corn planting. This allows the first growth of weeds to get well started, and the thorough plowing required in preparing the land leaves it so well cleaned that the millet easily keeps ahead of the weeds. If the land is very foul, the crop may be cut early, before the second growth of weeds goes to seed, and the land plowed again. Used in this way, millet is one of the best crops that can be grown for the purpose of ridding the land of weeds.

When millet is sown late in the season as a catch crop or as a second crop after rye or some other early maturing crop has been harvested, it is not always expedient to go to so much trouble in preparing the land. The seed may be sown on the freshly plowed stubble; or, if the land is quite loose and mellow, as is the case in parts of the West, the stubble may be "disked" or gone over with a cultivator to kill the weeds and the seed sown and harrowed in. This "disking" or cultivating is the most common practice when millet is used as a catch crop after the main crop of corn or small grain has been destroyed by hail, as is not infrequently the case in the middle West. Another quite common practice is to sow on newly broken ground, either without any other preparation than simply breaking up the sod, or, as is more often the case, the "breaking" is torn up with a "disk" or heavy iron-toothed harrow.

SEEDING.

When millet is handled as a primary crop, seeding is generally done during the latter part of May or early in June in the North, and, of course, correspondingly earlier in the South; or, if the moisture conditions are favorable, it may be delayed as late as August 1 in the latter region. It is a general rule to sow millet as soon as the corn is planted. The foxtail and broom-corn millets and some of the barnyard millets are quite sensitive to cold, and hence seeding should be postponed until the ground has become thoroughly warm and danger from protracted cold is past. It should, however, take place before the dry period of the summer begins. A succession of crops for soiling or silage can easily be obtained by sowing at periods of two or three weeks from May 10 to late in July.

The seed may be sown broadcast or with a grain drill. Ordinarily,

there is but little if any choice between the two methods when the crop is to be cut for hay, except that the drilled seed gives an evener stand and a little less seed is required. For a crop of grain or for soiling or ensilage, drilling will generally give better results. On some soils it is a good plan, when growing for seed, to plant in drills far enough apart to allow cultivation to prevent packing of the soil and loss of moisture, particularly when barnyard millet is planted.

The common practice is to sow from one-half to three-fourths of a bushel of seed of foxtail or broom-corn millets, or one-fourth to one-half of a bushel of barnyard millet per acre for a crop of hay and somewhat less for a crop of grain. Rich, well-prepared land will require less seed than that which is poor and thin; and it is not necessary to use quite so much seed when the crop is to be ensiled or fed in the fresh state as when it is intended for hay. Thin seeding is likely to result in coarse-stalked plants, which are not desirable for hay. Some of the varieties may require a smaller quantity of seed than others on account of the greater tendency of the plants to "stool;" but as the amount of "stooling" depends so much upon soil and climatic conditions, it is not usually safe to allow very much for it.

HARVESTING.

Cutting foxtail millets for hay should never be delayed until the seed has begun to ripen, particularly if it is to be fed to horses. On the other hand, it is best not to cut too early, as the hay is liable to have a more or less laxative effect upon the animals eating it. However, it is better cut early than late. The hay may be safely cut any time during the period from complete "heading out" to late bloom. Professor Chilcott, of the South Dakota experiment station, who has had much experience in growing and feeding this crop, says:[1] "The best time to cut millet for hay is when a majority of the heads have distinctly appeared." The tough, fibrous nature of the stems and the stiff beards on the heads of millet that has been allowed to approach too close to maturity detract much from the palatability of the hay, and, although something is gained from the seeds by way of nutriment, enough is lost in palatability and increased fiber to more than make up for it. Moreover, the earlier cut hay is a much safer food for all kinds of stock. On account of the succulency of the stems and leaves the curing takes place rather slowly, and the seeds may make a great deal of development after the plants are cut; hence, if cutting is delayed until after the seeds are well formed, they will often develop sufficiently during the process of curing to germinate. Cutting for soiling or for the silo can be done a little later than for hay, but should take place before the seed has begun to ripen.

For soiling or for early hay, barnyard millets may be cut as soon as the grass "heads out," or even before. The best quality of forage

[1] S. Dak. Agr. Exp. Sta., Bul. No. 51, p. 18. 1897.

will be obtained by cutting during the blooming period, and when the crop is to be cured for hay this is the best time for harvesting. For silage the crop may be cut any time between "heading out" and the formation of the seed, preferably when most of the plants are in late bloom. The quality of the forage seems to deteriorate more rapidly with age than in the foxtail millets; hence it is more imperative that cutting should be done while the plants are at their best.

On account of the greater succulency of the stems, barnyard millet is more difficult to cure than either the broom-corn or the foxtail millets, but when properly cured the quality of the hay is better than that of the other millets, and in some localities the yield is said to be greater.

One of the best methods of preserving this crop is by the use of the silo. Those who have tried this method have obtained excellent results. A fine quality of ensilage may be made by using barnyard millet and a leguminous crop like soy beans or clover.

The broom corn millets are not difficult to cure, and the same methods may be employed as for any coarse grass. What has been said regarding the time for cutting barnyard millet for various purposes applies as well to the millets of this group. The forage deteriorates rapidly upon reaching maturity, and hence cutting should not be delayed too long.

The common practice is to use a horse mower or a scythe when cutting for hay or soiling. In localities where curing takes place rapidly and there is little or no rain during haying time, the self-rake and the self-binder have been used with good results. The bunches left by the self-rake are allowed to lie without further attention until cured; or possibly, in the case of a heavy yield, they may be turned over once or twice to facilitate drying. When the self-binder is used the bundles are loosely made, and are set up "two and two" in long shocks extending north and south, so that the bundles may get the full benefit of the sunshine. It is not often that this method can be employed in cutting for hay, but when practicable it saves much labor and leaves the hay in condition to be stored easily and well. Another way of using the self binder is to allow the millet to be dropped unbound to the ground, the bunches then being handled as when the self-rake is used.

One of the best methods of curing the hay is to allow the grass to lie in the swath until partially dry, then gather into cocks and let stand until thoroughly cured, after the manner of curing alfalfa and clover. Hay cured in this way is of better quality than that allowed to lie in the swath exposed to the sun until dry.

Millets may be harvested for the seed in the same manner as small grain of any sort. One of the best ways is to cut with a self-binder, place the bundles "two and two" in long, narrow shocks, with the long diameter north and south, let stand until dry, and thrash from the shocks. This method is quite generally practiced where the millets are most extensively grown for seed. It is possible that seed of a better quality may be obtained by stacking the millet before thrashing; but

whether or not the gain would be sufficient to pay for the expense of stacking is doubtful. The crop should not be allowed to become too ripe before cutting, for the seed falls out badly during the process of curing and thrashing. Probably the best time for harvesting for a crop of seed is when the seed is in a "stiff dough."

USES AND FEEDING VALUE.

Millet is fed principally as a hay and soiling crop. As will be seen from the chemical analyses (p. 26), the forage ranks well with that of other grasses in the nutritive content, and its palatability is about that of the average for the coarser sorts. For digestibility, millet forage compares favorably with that from other coarse grasses.

Already widely grown as a hay crop, millets deserve more general use for soiling. They are particularly valuable for feeding to dairy cattle, young stock, and sheep. There are many sections of the country where this crop can be made to supplement the pastures in such a way as to allow a material increase in the number of stock that can be kept on the farm.

The use of millet as an element in annual pastures may well receive greater attention from farmers in sections where there is a general shortage of pasturage. Such varieties as Hungarian and Common Millet, which "sprout from the root" well, are best to sow for pasturage. Some of the Korean varieties may prove valuable for this purpose. There are few of the annual grasses better adapted for use in pastures. Sheep and calves may be pastured on this crop with excellent results. It would be well to mix some other crop, like field peas, with the millet, or to allow the animals to run on a field of clover, rape, or some such crop for a portion of the time.

On account of the heavy yield of forage and the good quality of the product, millets are excellent grasses for use in the silo. Frequently a good crop of millet can be raised under conditions which would not admit of growing corn for ensiling, and in such instances it becomes of especial value.

The seed of the foxtail millets is widely used as food for fowls and birds, but is seldom fed to stock. It has, however, been used in feeding young stock, such as calves, with a fair degree of success. It should never be fed without first being ground or crushed, as otherwise only a portion is masticated and digested, and the rest is lost. The seed is an excellent food for laying hens.

The seed for Broom-corn Millet has won greater favor in this country as a food for stock than that of either the foxtail or barnyard millets. It has been fed to swine and young cattle with very satisfactory results, and is regarded as an excellent substitute for corn for use in preparing animals for the market. The name "Hog Millet," so commonly applied in the West and Northwest, was given because of the fact that the seed was thought to be so well adapted for feeding hogs. As with other

millets, the seed makes a good poultry food, and it forms a large part of the various birdseed mixtures offered in the market. The broom-corn millets are better adapted for human food than any other millets grown in this country.

COMPOSITION AND DIGESTIBILITY.

The millets are all much alike in composition and digestibility, there being often more variation in the forage from a single variety cut at different periods in the development of the plant than between that from different varieties, particularly when cut at about the same stage of growth. This shows the importance of cutting at the proper time in order to obtain the richest, most palatable, and most digestible forage

Compared with timothy, which is usually taken as the standard for grasses, the foxtail millets are somewhat deficient in the two most important constituents, fat and crude protein, but they contain about the same percentage of crude cellulose and a slightly higher percentage of extract matter. The percentages of digestibility are somewhat higher, however, in the millets, so that the actual feeding value differs but little, although the timothy is perhaps more palatable. The seed contains almost as much fat and extract matter as shelled corn, a little more protein, and about four times as much crude cellulose.

Hungarian hay is more digestible than corn stover, but rather less so than good fodder. Sixty-five per cent of the total dry matter is digestible, and of the fresh material 63 per cent. As the hay ordinarily contains from 7 to 15 per cent of water, leaving a total amount of from 85 to 93 per cent of dry matter, or 85 to 93 pounds in each 100 pounds of hay, it will be seen that the animal digests from 55½ to 60½ pounds of the total dry matter in each 100 pounds of hay.

Barnyard-millet hay contains rather more fat and crude protein and less extract matter than the foxtail millets, and about the same amount of crude cellulose. It also has a somewhat higher percentage of digestibility, bearing out the opinions of Professor Brooks, Dr. Lindsey, and others, that it yields, all things considered, a forage superior to that of the foxtail and broom-corn millets.

The Broom-corn Millet agrees fairly well in composition with the barnyard and foxtail millets, the most important differences being in the composition of the seed and silage. The silage is relatively rich in fat, while the seed is richer in both fat and protein than most of the foxtail millets, and richer in protein but poorer in fat than the barnyard millet. Data as to its digestibility are not available, but the chemical analyses indicate a relatively high food value for properly preserved forage, and this agrees with the general experience of stock feeders. In palatability it is considered by some to be rather behind both foxtail and barnyard millets, but our experience indicates that it is at least fully equal to the former in this respect, though somewhat behind the latter.

The following tables give the chemical composition and digestibility of the millets as shown by various American analyses and digestion experiments. No data on the digestibility of Broom corn Millet are at present obtainable:

I.—*Average chemical composition of millets.*

Variety and kind of forage.	Fresh or air-dry substance.						Water-free substance.				
	Water.	Ash.	Crude cellulose.	Fat.	Crude protein.	Nitrogen-free extract.	Ash.	Crude cellulose.	Fat.	Crude protein.	Nitrogen-free extract.
Foxtail Millets:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Hungarian (hay)	7.7	6.0	27.7	2.1	7.5	49.0	6.5	30.0	2.3	8.1	53.1
Common (hay)	15.0	4.3	28.3	1.8	6.6	44.0	.....	33.3	2.1	7.8	51.8
Japanese Foxtail (hay)	15.0	4.7	30.1	1.8	5.1	43.3	.....	35.4	2.1	6.0	50.9
"Golden" (hay)	14.0	.....	25.5	1.7	6.4	45.7	.....	.....	.....	.....	.....
Early Harvest[1]	26.8	5.1	26.9	1.7	4.3	35.2	6.9	36.7	2.3	6.0	48.1
Millet straw	15.0	5.8	35.5	1.2	4.2	38.3	.....	41.8	1.4	4.9	45.1
Common (fresh)	65.0	1.7	11.0	1.0	2.6	18.7	.....	31.4	2.9	7.4	53.4
Japanese Foxtail (fresh)	75.0	1.5	7.8	0.5	2.1	13.1	.....	31.2	2.0	8.2	52.5
Hungarian (fresh)	74.0	2.1	7.0	0.5	2.6	13.8	.....	26.9	1.9	10.0	53.1
Millet seed (variety unknown)	12.8	3.4	7.8	3.8	11.0	61.2	3.9	9.1	4.5	12.5	70.0
Millet seed (hulled, grown in India)	10.2	1.2	1.5	2.9	10.8	73.4	.....	.....	.....	.....	.....
Golden Wonder Millet seed	9.3	3.0	9.1	4.5	13.8	60.5	3.3	10.1	4.9	15.0	66.7
Barnyard Millets:											
Freshly cut (for soiling)	73.1	2.0	8.1	0.8	2.0	14.0	.....	30.0	3.0	7.5	52.0
Hay	11.0	8.9	30.9	2.2	11.3	35.7	10.0	34.6	2.5	12.7	40.2
Straw	15.0	4.6	30.4	2.1	5.2	42.7	5.4	35.8	2.5	6.1	50.2
Silage	71.8	2.8	9.6	0.8	1.7	13.3	9.7	34.0	3.0	6.2	47.1
Seed	10.3	3.1	7.7	5.7	12.3	60.9	3.5	8.6	6.3	13.7	67.9
Broom-corn Millets:											
Japanese Broom-corn[1]	38.5	3.7	19.3	1.0	2.6	34.9	5.9	31.3	1.7	4.3	56.8
Silage	78.0	1.8	7.0	0.7	1.7	10.8	8.3	31.8	3.3	7.5	49.1
Hog Millet seed	10.2	2.3	6.6	4.4	13.5	63.0	2.6	7.3	5.0	15.0	70.1

[1] Partially cured.

II.—*Digestibility of millets.*

Variety and kind of forage.	Dry matter.	Organic matter.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free extract.	Remarks.
Foxtail Millets:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Hungarian (hay)	65	66	.....	68	64	60	67	Experiments made with ruminants in this and the next.
Hungarian (fresh)	63	68	.....	70	62	63	67	Early to late bloom.
"Golden" (hay)	.....	.....	.....	58	41	60	65	
Barnyard Millets:								
Fresh fodder	65	53	63	72	47	68		Bloom to early seed; average of 3 trials with sheep.
Fresh fodder[1]	67	66	74	64	68	76		Experiment began when millet was just heading out.
Hay[1]	59	63	62	46	64	52		Rather late bloom.

[1] Analyses furnished by Dr. J. B. Lindsey, Massachusetts (Hatch) Experiment Station.

FERTILIZING VALUE OF MILLETS.

While this crop is of little importance as a fertilizer, when compared with the clovers, cowpeas, and other leguminous crops, a knowledge of the kind and quantity of fertilizing substances contained in the millet plant will give an idea as to the drain on the elements of plant food in the soil by this crop. There are many sections of the country in which the soil is very poorly supplied with vegetable mold, and the turning under of any leafy growth will prove beneficial. If the better leguminous crops are not at hand or can not be grown, millet or any other plant that will grow on the soil and produce a heavy foliage may well be used for the purpose.

The following table shows the amount, in pounds, of the various important fertilizing ingredients found in the millets, and also the comparative value of a ton of the hay, straw, seed, or fresh material at an average market price for these ingredients:

Fertilizing value of the millets.[1]

Variety.	Nitrogen.	Phosphoric acid.	Potash.	Value.
	Pounds.	*Pounds.*	*Pounds.*	*Dollars.*
Japanese Foxtail Millet (fresh)	12.2	3.8	8.2	2.05
Barnyard Millet (fresh)	9.2	2.2	9.8	1.69
Hungarian Millet (fresh)	7.8	3.2	10.8	1.62
Millet ensilage (var. unknown)	5.2	2.8	12.4	1.37
Millet hay (var. unknown)	24.4	9.2	32.2	4.95
Millet straw	13.6	3.6	34.6	3.52
Japanese Millet seed	34.6	13.8	7.6	5.15
Common Millet seed	40.2	19.2	9	6.02

[1] Adapted from Ninth An. Rep. Mass. (Hatch) Agr. Exp. Sta.

REPUTED INJURIOUSNESS OF FOXTAIL MILLET FORAGE.

In some sections of the country the foxtail millets have gained the reputation of being injurious to certain kinds of stock, and are therefore regarded with suspicion by many farmers and stockmen. Like many other forage plants, these millets become very harsh and woody with age, and are then difficult of thorough mastication and hard to digest. Then, too, at this stage of growth the beards are stiff and harsh, and are not only difficult to digest, but produce more or less irritation in the digestive tract of the animal, and sometimes unite with other indigestible substances, forming compact balls in the stomach, ultimately causing death. This difficulty may be avoided by cutting the hay in proper season, as recommended elsewhere. No more trouble seems to have been experienced in feeding the millets in the fresh state than with any other succulent forage. Most of the injury has arisen from feeding the hay in large quantities with little or no other grain or forage and for extended periods. At the North Dakota experiment station an extended experiment was recently conducted to determine what, if any, deleterious effects would result to horses from a continued

diet in which millet hay replaced that ordinarily used in the ration. The animals were grained, watered, and otherwise cared for as usual. At the end of the experiment Dr. Hinebauch,[1] the veterinarian of the station, concluded that "millet, when used alone as a coarse food, is injurious to horses—first, in producing an increased action of the kidneys; second, in causing lameness and swelling of the joints; third, in producing infusion of blood into the joints; fourth, in destroying the texture of the bone, rendering it softer and less tenacious, so that traction causes the ligaments and muscles to be torn loose." These results seem to show conclusively that under certain conditions millet hay becomes injurious to horses at least, if not to other stock also. This agrees, too, with the general experience of farmers and stockmen, that a long continued diet of millet hay, particularly hay in poor condition, tends to weaken horses and unfit them for doing hard work. Again, both immature and overripe foxtail millet is said to produce abortion in brood mares and cows, but this has not been established experimentally.

More recently Professor Ladd,[2] of the same experiment station, has made a chemical study of millet hay, in which he succeeded in isolating a glucoside which he calls Setarian, and which, from its physiological action on mice, rats, and young cats, he concludes to be the cause of the injury to horses and other stock.

Millet in any stage of growth acts as a laxative and diuretic. At times the action is more pronounced than at others. Thus hay cut while the plants are quite young seems to be most strongly laxative, while overripe hay is most strongly diuretic. However, if the hay is cut at the right stage of growth and properly cured, the action in either case will not be sufficient to lead to serious results if other hay or coarse forage is fed along with the millet. One feed of millet hay per day for work horses and one or two for other stock is sufficient, and when fed in this manner the millet acts as a stimulant and alterative and tends to produce and maintain a healthy condition of the animals.

---

[1] North Dakota Experiment Station Bul. No. 26, p. 105. 1896.

[2] North Dakota Experiment Station Bul. No. 35, p. 323. 1899. See also Amer. Chem. Journ.: No. 20, p. 861.

XUM